BACTERIOLOGICAL WATER QUALITY IN THE BAY OF QUINTE

May 1984

Ontario
Ministry of the Environment

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BACTERIOLOGICAL WATER QUALITY IN THE BAY OF QUINTE

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Water Resources Branch
Ministry of the Environment

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ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance of Mr. L. Ellenton of the Hastings and Prince Edward Counties Health Unit who provided bacteriological analyses of water samples collected at public swimming areas. Thanks are extended to Mr. D.E. Graham and Mr. G. McRae of MOE Southeastern Region for their provision of plans showing sewer outfalls for the cities of Trenton and Belleville, and the town of Picton, respectively. Sincere appreciation is expressed to Ms. J. Barnes for summary and analysis of data and production of graphics. Greatful appreciation is given to D.N. Jeffs, F.C. Fleischer, J.D. Kinkead. Y. Hamdy, M.J. German and D. Boyd for extensive and constructive review of the manuscript.

EXECUTIVE SUMMARY

Data collected by the Ontario Ministry of the Environment (MOE) in 1981 and 1982, and by the local Health Unit in 1982, determined that Bay of Quinte waters in the vicinity of Trenton, Belleville, and Picton displayed zones of elevated fecal coliform (FC) levels as a result of unchlorinated urban discharges. These discharges appeared to be intermittent, however, and led only to short term elevations in bacterial levels with the result that seasonal geometric mean levels at all public beaches remained below the Provincial Water Quality Objective (PWQO) for FC of 100 organisms/100 mL.

A summary of the findings is presented below.

1. TRENTON

In the August 1981 MOE survey, bacteriological zones with single sample FC levels greater than 100 organisms/100 mL were found to extend from the Trent River mouth into the Bay of Quinte for distances ranging from 1 to 2 km on four of the six sampling days. Elevated FC levels within these zones appeared to be associated with discharges into the lower reaches of the Trent River (mainly south of Highway 2) and were not related to the chlorinated discharges from either the Trenton or Trenton Canadian Forces Base sewage treatment plants (STP's). Extensive zones of bacterial degradation were observed during dry weather conditions suggesting the existence of illegal connections within the municipal sewer collection system, bypassing, and/or the presence of other unmeasured source(s). A follow-up MOE survey conducted in the summer of 1982 found that the highest incidence of fecal coliform densities exceeding 100 organisms/100 mL occurred downstream of Domtar Packaging Limited, a pulp and paper mill. The effluent of Domtar Packaging was not investigated but should it prove to be a source of bacteria it may contain Klebsiella pneumonia.

The Health Unit data collected at two local beaches (Trent River beach and Fraser Street beach) over the period May through August 1982 indicated that the seasonal geometric mean FC levels of 30 and 65 organisms/100 mL respectively were below the PWQO but that single sample levels exceeded the 100 organisms/100 mL level on 16% and 23% of the sampling days respectively.

2. BELLEVILLE

The August 1981 MOE survey found an extensive bacteriological zone with FC single sample levels greater than 100 organisms/100 mL on three of the six sampling days. During low precipitation periods this zone of bacterial degradation was chiefly confined to the Moira River mouth. Following heavy rainfall (15 mm on two preceeding days), the zone extended eastward along the Belleville waterfront for a distance of approximately 3 km and was the most extensive of all observed in this Bay of Quinte survey.

Local Health Unit data for 1982 indicated that the two area beaches displayed seasonal geometric mean FC levels below the PWQO, (Government Dock beach: 58 organisms/100 mL, Zwick Island beach: 91 organisms/100 mL) with single sample levels of greater than 100 organisms/100 mL occuring on 35% and 46% of the sampling days respectively. Note that the Zwick Island is the most extensively used beach in the Bay of Quinte and that it exhibited the highest fecal coliform levels of all beaches sampled in the study area.

Both MOE and Health Unit results suggest that the localized bacteriological degradation of Bay of Quinte waters at Belleville was related to wet weather raw sewage bypassing to the Moira River and Bay of Quinte, and did not result from the discharge of treated chlorinated effluent from the Belleville STP.

The City of Belleville sewer system is currently being modified to eliminate this bypassing and to discharge directly to the new expanded Belleville sewage treatment plant.

3. DESERONTO

No clearly established bacteriological impairment zone was detected in the Deseronto area during the MOE August 1981 survey and no impairment resulting from STP discharges was evident.

Health Unit sampling at the local Centennial Park beach in the summer of 1982 indicated seasonal geometric mean FC levels of 58 organisms/100 mL and thus below the PWQO. Single sample levels of greater than 100 organisms/100 mL occured on 26% of the sampling days. The nearby Arctic Gardens Limited plant's effluent may contribute to some of the elevated bacterial levels found at that beach.

4. PICTON

The MOE survey in the vicinity of Picton in August 1981 detected bacteriological zones with single sample levels greater than 100 organisms/100 mL on four of the six sampling days. These zones were confined to less than 1 km from the southern end of Picton Bay and appeared to be attributable to municipal sewer discharges rather than to the chlorinated effluent from the Picton STP. No swimming beaches are located in the Picton area.

RECOMMENDATIONS

1. TRENTON

A source assessment study should be initiated by the MOE Southeastern Region in Trenton aimed at identifying all major bacteriological inputs into the area and assessing their relative magnitude and significance in order that corrective measures could be developed to alleviate bacterial contamination in the receiving water and especially at local beaches. Specifically, the potential source of bacterial degradation associated with Domtar Packaging should be investigated especially with reference to Klebsiella pneumonia. Should Klebsiella be found to be a significant component of the Domtar Packaging effluent, then the bacteriological conditions near Trenton should be re-assessed since Klebsiella pneumonia has been found to interfere with the fecal coliform test.

2. BELLEVILLE

A bacteriological study should be carried out by the MOE Great Lakes Section after the completion of the Belleville STP expansion to assess the effectiveness of remedial measures.

3. DESERONTO

A special bacteriological study of the Deseronto area should be carried out by the MOE Southeastern Region to assess the reasons for the moderate bacteriological degradation of Centennial Park beach documented by the local Health Unit. Specifically, Arctic Gardens Limited plant's effluent should be investigated as a possible source of bacterial contamination.

4. PICTON

The capacity of the Picton municipal sewage collection system and STP should be investigated by the MOE Southeastern Region to determine if a solution can be found to further minimize overflows at the combined (and possibly storm) sewers and thus reduce the bacterial contamination of the receiving waters.

5. GENERAL

At the present time discontinuation of chlorination at STP's during the winter months is not advisable other than on a trial basis because of extensive winter use of the Bay of Quinte for ice fishing. If chlorination of the STP effluent is discontinued during winter months sampling of the receiving waters should be initiated to monitor bacteriological quality to ascertain compliance with Provincial Water Quality Objectives.

I. INTRODUCTION AND STUDY RATIONALE

The Bay of Quinte encompasses the numerous reaches and bays north and east of Prince Edward County on the north shore of eastern Lake Ontario (Figure 1). The width of these reaches and bays varies from approximately 400 m to 1,400 m, while the mid-channel depth varies from about 5 m to 8 m.

The confined nature of this body of water in combination with numerous urban discharges (STPs, storm sewers, combined sewer overflows) has resulted in the potential for contamination. Since the Bay of Quinte is used extensively for recreation, such as boating, swimming, and fishing, an assessment of bacteriological water quality throughout the area was deemed necessary.

The Great Lakes Section of the Water Resources Branch (MOE) initiated a survey in the summer of 1981 aimed at:

i) documenting selected STP and river sources of bacterial inputs discharging into the Bay of Quinte;

ii) assessing the effects of these inputs on the receiving waters; and

iii) recommending remedial measures.

In a follow up study (1982), the Southeastern Region (MOE) concentrated on the Trenton area and assessed the effectiveness of Trenton STP effluent chlorination on bacterial levels and determined the degree of bacterial contaminants in the Trenton River.

In addition to the above studies, the Hastings and Prince Edward Counties Health Unit carried out a monitoring program at Bay of Quinte beaches in order to assess their suitability for bathing.

This report summarizes available fecal coliform (FC) and related data from the above studies and discusses their significance.

II. SURVEY DESIGN

(a) Great Lakes Section, Water Resources Branch, MOE, August 1981

The Great Lakes Section initiated a study in the Bay of Quinte by establishing an intensive grid of stations near Trenton, Belleville, Deseronto, and Picton to permit detailed areal coverage near bacterial input sources (Figure 1). Intervening areas were sampled less intensively to establish background conditions. In addition, effluent samples were obtained to establish input levels at the following sewage treatment plants (STPs): Trenton, Trenton Canadian Forces Base, Belleville, Deseronto, and Picton.

One complete coverage of the survey area required three days starting at Trenton and ending near Picton. The entire study area was sampled six times over a period of 18 days according to the schedule outlined below.

Sampling Schedule

Sector	Date
Trenton to Belleville	August 8,11,14,21,24,27.
Belleville to Deseronto	August 9,12,15,22,25,28.
Deseronto to Picton	August 10,13,16,23,26,29.

At each station a bacteriological sample was taken at a depth of 1 m below the water surface. All samples were analyzed for fecal coliforms at a MOE mobile lab located in Belleville.

The data was summarized into six sets, each consisting of one complete coverage of the Bay of Quinte (Figures 2-7).

(b) Southeastern Region, MOE, July-September 1982

A separate study was carried out by the MOE Southeastern Regional Office at Trenton in the area of the lower Trent River and adjacent Bay of Quinte shoreline. Thirty stations were monitored upstream and downstream from the Trenton STP and in the Trent River, and analyzed for a variety of water quality parameters, including fecal coliforms. Significant results from that study are briefly discussed in the section dealing with Trenton.

(c) Hastings and Prince Edward Counties Health Unit, May-August 1982.

Bacteriological sampling was undertaken by the local Health Unit at five public beaches located at Trenton, Belleville and Deseronto. (Figure 14) as part of a continuing long term beach monitoring program. The samples were taken once a week during the recreational period by wading into the water and sampling in 1 to 1.5 ft water depth, 4 inches from the water surface. The 1982 results are summarized in Table 1. (The 1981 results are not included since only limited sampling was conducted at the beaches during that year.) In computing the seasonal geometric means, all less than and greater than numbers were taken at face value, thus underestimating slightly the true mean which could only be calculated had the less than and greater than values been quantified.

Meteorological data were obtained from local Atmospheric Environment offices and are presented in Figures 8 - 13.

III. BACTERIOLOGICAL WATER QUALITY IN THE BAY OF QUINTE

This report deals mainly with data collected by MOE Great Lakes Section throughout the Bay of Quinte in August 1981 and presented numerically in Figures 2 to 7. All data were examined, and a series of maps have been prepared depicting zones in the receiving waters where single sample F.C. levels exceed 100 organisms/100 mL (Figures 8 to 13). It should be emphasized that the Provincial Water Quality objective (PWQO) of 100 organisms/100 mL F.C. is to be applied to the geometric mean of a series of samples and that Figures 8 to 13 merely depict single sample levels as a means of illustrating zones of potential impairment.

The results of the MOE Trenton survey undertaken in 1982 by the Southeastern Region are discussed briefly where applicable but are not presented fully in this report. The 1982 Health Unit data for the Bay of Quinte beaches (Figure 14) have been summarized in Table 1. Note that these samples were taken in shallow water and are, therefore, likely to overestimate bacterial populations at the more common swimming depth of 1.0 to 1.5 m.

TABLE 1 FECAL COLIFORM LEVELS AT BAY OF QUINTE BEACHES, 1982 SUMMER

Location	Beach	Geometric mean org/100 mls	Maximum level org/100 mls	% Samples above 100 org/100 mls
Trenton	Trent River	30	620	16
Trenton	Fraser Street	65	660	23
Belleville	Government Dock	58	1200	35
Belleville	Zwick Island	91	960	46
Deseronto	Centennial Park	58	1200	28

The discussion that follows deals with each urban area separately.

TRENTON

a) Inputs

Known bacteriological inputs into the Trenton area consist of the Trenton STP and Trenton Canadian Forces Base STP effluents, two combined sewer overflows and numerous storm sewers discharging mainly into the lower reaches of the Trent River. The Trenton STP is a conventional activated sludge plant with secondary treatment and an average daily flow of 11,900 m^3 (2.6 MGD). The Trenton Canadian Forces Base STP is an extended aeration plant with secondary treatment and an average daily flow of 4,500 m^3 (1 MGD). The 1981 study was concerned only with documenting inputs from STP's and River mouths and did not attempt to quantify discharges from industry or municipal sewers. At present it is not known conclusively if any industrial discharges in the area contribute to bacteriological degradation of the receiving waters although the 1982 Southeastern Region study did find elevated bacteria levels downstream from Domtar Packaging suggesting that that plant may be a contributor. Since Domtar Packaging is a pulp and paper mill, its effluent may be expected to contain Klebsiella pneumonia.

Analysis of the Trenton STP effluent revealed very low bacteriological inputs from that source during the study period (Table 1). Fecal coliform levels were near or at zero in approximately 50% of the samples taken and never exceeded 40 organisms/100 mL during the August 1982 study. Chlorination of the final STP effluent is obviously effective in reducing bacterial inputs from that source.

The Trenton Canadian Forces Base STP effluent exhibited somewhat variable bacteriological levels which fluctuated between <4 and $>15,000$ fecal coliform organisms/100 mL.

b) Receiving Water

Extensive bacteriological zones with single sample levels greater than 100 organisms/100 mL were detected at the mouth of the Trent River on four of the six sampling days. These zones extended approximately 1 km from the mouth of the Trent River into the Bay of Quinte on August 8, 11, and 14, and nearly 2 km on August 24 (Figures 8, 9, 10, 12).

No direct correlation was apparent between precipitation during and prior to survey days and the extent of the elevated bacteriological zones. In fact, the greatest extent of these zones occurred on August 14 and 24 when virtually no precipitation was recorded prior to or during the survey. Since wet weather discharge from combined and storm sewers did not appear to be responsible for the elevated levels, the existence of dry weather sewer flows (e.g. from illegal sewer connection(s) or bypassing) or other unmeasured sources (e.g. Domtar Packaging) must be considered. Should Domtar Packaging effluent be found to contain a significant Klebsiella pneumonia component, then the bacteriological status of waters near Trenton should be re-assessed since Klebsiella pneumonia has been noted to interfere with the fecal coliform test. The health implications of Klebsiella pneumonia itself are unclear at present.

With the exception of the Trent River mouth, no bacteriological degradation was noted elsewhere along the Trenton waterfront. Results from the MOE Southeastern Region survey in 1982 confirmed the 1981 observation that the Trenton STP was not a significant bacteriological input to this area. Bacteriological levels in the offshore area of the Trenton Canadian Forces Base (CFB) appeared unaffected by that STP's effluent discharge although the existing grid did not permit a full assessment of the potential effect of that STP on the nearshore bacteriological quality. In view of periodically elevated bacterial levels of the Trenton CFB STP effluent, it is possible that at certain times a zone of effect may be detected.

c) Beaches

Two recreational beaches in the Trenton area have been monitored by the local Health Unit. These are located west of the Trent River mouth at Fraser Street (beach #1), on the Trent River at Highway #2 (beach #2) (Fig. 14). A 1982 summary of data generated by this beach sampling program is presented in Table 1.

The data indicate that for the period May to August 1982, the geometric mean FC levels at both beaches were below the PWQO (100 organisms/100 mL) with values of 65 and 30 organisms/100 mL respectively. Individual sample levels exceeded 100 organisms/100 mL in 23% of the samples at beach #1, in 16% of the samples at beach #2.

Although the MOE survey in August 1981 did not monitor the actual Health Unit beach stations, samples obtained in the vicinity of beach #2 show FC levels there to be greater than 100 organisms/100 mL on four of the six sampling days (August 8, 11, 14, 24). The water near Beach #1 was on the fringe of the elevated zones for three of the six days (August 8, 11, 14) and was clearly greater than 100 organisms/100 mL on August 24.

Results from the 1982 MOE Southeastern Region survey carried out near beach #2 showed a geometric mean FC level of 54 organisms/100 mL while individual day results exceeded the 100 organisms/100 mL level in 30% of the samples.

On the basis of these three sets of data it can be stated that, in general, recreational season geometric mean FC levels at beaches located near the mouth of the Trent River remained below the PWQO, but that single sample levels exceeded 100 organisms/100 mL on numerous occasions.

BELLEVILLE

a) Inputs

Known bacteriological inputs into the Belleville area consist of the Belleville STP, one combined sewer overflow and numerous storm sewers discharging both into the Moira River and into the Bay of Quinte along the Belleville waterfront. The existing Belleville STP is a conventional activated sludge plant (secondary treatment) with a design capacity of 36,400 m^3/day (8 MGD) and a peak capacity of 54,500 m^3/day (12 MGD). Presently, this plant is undergoing an expansion. The expanded plant will provide complete treatment for 54,500 m^3/day and physical and chemical treatments (including phosphorus removal) in the expanded primary facility for flows up to 109,100 m^3/day (24 MGD) with a peak capacity of 163,500 m^3/day (36 MGD). The chlorinated effluent will be discharged to Bay of Quinte through an extended diffuser outfall. This diffuser outfall will have a capacity for flows up to about 36 MGD. Flows in excess of this capacity will be discharged through the existing outfall.

The bacteriological content of the Belleville STP effluent was highly variable, ranging from 100 organisms/100 mL to 47,000 organisms/100 mL. Much of this variability may have resulted from variations in chlorine contact time, and the extreme values are not considered representative of the discharge into the Bay.

b) Receiving Water

Extensive bacteriological zones with single sample FC levels greater than 100 organisms/100 mL were detected at the mouth of the Moira River on three of the six sampling days (August 9, 12, 15). The zones extended nearly 1 km out into the Bay on August 9 and 15 (Figures 8, 10) and about 1 km out into the Bay and 3 km to the east on August 12 (Figure 9). Elevated bacterial levels were generally confined to the Moira River on August 22 (Figure 11) and extended approximately 0.4 km from the river mouth on August 25 and 28 (Figures 12 and 13).

A direct variation between FC levels and daily precipitation totals was evident, with the greatest elevated zone, measured on August 12, detected following 15 mm of rain on August 10 and 11 (Figure 9). On this occasion, a zone of single sample levels greater than 1,000 organisms/100 mL was measured to extend nearly 1 km out into the Bay. This can be attributed to bypassing of raw sewage to the Moira River following precipitation events as the result of limited plant capacity. Under dry conditions (August 22) the elevated FC zone was confined entirely to the Moira River. Sampling in the Bay near the Belleville STP outfall detected no significant FC contribution from this source on any of the sampling days.

c) Beaches

Belleville beaches monitored by the local Health Unit are located west of the Moira River at Zwick Island (beach # 3,) and east of the Moira River at the Government Dock (beach # 4) (Fig. 14).

In 1982, Zwick Island beach, the most widely used beach in the Bay of Quinte (according to the local Health Unit), exhibited the highest fecal coliform levels of all beaches sampled in the study area that year. Although in the past years it exhibited one of the lowest levels (in 1980 FC geometric mean was 30 organisms/100 mL), in 1982 this beach had a FC geometric mean of 91 organisms/100mL and 46% of the individual sample levels were greater than 100 organisms/100 mL. This apparent increase in coliform densities observed in 1982 may have been due, in part, to construction work on a nearby swing bridge and other work in an adjacent inlet carried out by the City of Belleville. The MOE survey did not show a significant impact of the Moira River on the beach.

The Government Dock beach located in a sheltered area, had a somewhat lower geometric mean FC level of 58 organisms/100 mL in 1982. The MOE results of August 1981 from an area near the Government Dock (Figures 8 to 13) found individual sample levels in excess of 100 organisms/100 mL on three of the six sampling days

(August 9, 12, 15) with August 9 levels exceeding 500 organisms/100 mL and August 12 levels exceeding 1,000 organisms/100 mL. At times, the Government Dock beach is clearly under the influence of the Moira River as well as the storm sewers, especially under high flow conditions.

Both these sets of results indicate that although the summer 1982 geometric mean FC levels at recreational beaches were below the PWQO, occasionally single sample levels greatly exceeded 100 organisms/100 mL, especially following intense precipitation events.

DESERONTO

a) Inputs

Known bacteriological inputs into the Deseronto area consist of the Deseronto STP and a number of storm sewers. The Deseronto STP is an extended aeration plant (secondary treatment) with an average daily flow of 1000 m^3 (0.22 MGD). The fecal coliform levels in the Deseronto STP effluent were found to be generally low, ranging from 12 to 540 organisms/100 mL. In addition to the above, Arctic Gardens Limited effluent may represent another potential source of bacteria, especially during the summer corn processing season when the plant's treatment system is overloaded and virtually ineffective (personal communication, M.G. German). Arctic Gardens Limited process effluent was not investigated in this study.

b) Receiving Waters

No clearly established bacteriological degradation was detected in the Deseronto area during the MOE August 1981 survey. Typical nearshore values ranged from less than 2 organisms/100 mL to 32 organisms/100 mL. Occasionally elevated levels (greater than 200 organisms/100 mL) were detected at isolated locations (Figure 4, 6), apparently unrelated to measured discharge from the STP.

c) Beaches

The only recreational beach monitored by the local Health Unit in Deseronto is beach #5 located at Centennial Park (Fig. 14). In the summer of 1982, the geometric mean FC level was 58 organisms/100 mL and single sample levels in excess of 100 organisms/100 mL were recorded 28% of the time. This beach may be influenced by the Arctic Gardens Limited process and therefore there exists a need to evaluate this potential relationship.

PICTON

a) Inputs

Bacteriological inputs into Picton Bay include the Picton STP effluent (which discharges into Picton Bay via a small creek), three combined sewer overflows, and one storm sewer. The Picton STP is an extended aeration plant (secondary treatment) with an average daily flow of 3600 m^3 (0.79 MGD). The FC levels in the Picton STP effluent were generally low, ranging from <4 organisms/100 mL to 300 organisms/100 mL.

b) Receiving Waters

Extensive bacteriological zones with single sample FC levels greater than 100 organisms/100 mL were observed on four of the six sampling days (August 10, 13, 16, and 29). However, these zones were generally confined to less than 1 km from the southern end of Picton Bay. Although a direct link between the extent of the bacteriological zones and precipitation was not as clear as for Belleville, during the two days when elevated FC zones were not detected virtually no precipitation was recorded. Since sampling at the Picton STP indicated low FC levels, these zones appeared to be attributable to wet weather inputs from combined and storm sewers, as well as limited exchange with the rest of the Bay. An ongoing sewer separation program is attempting to reduce overflow incidences and thus improve water quality in Picton Bay.

c) Beaches

No public beaches are located in Picton Bay. The waters are used primarily for boating and a small marina is located in the southern corner of the Bay.

IV CONCLUSIONS

Data collected by the Ontario Ministry of the Environment (MOE) in 1981 and 1982, and by the local Health Unit in 1982, determined that Bay of Quinte waters in the vicinity of Trenton, Belleville, and Picton displayed zones of elevated fecal coliform levels as a result of unchlorinated urban discharges.

The most bacteriologically degraded site in the study area was Belleville where extensive zones of impact were found to be related to wet weather raw sewage bypassing from the Belleville sewage treatment plant. This problem is presently being corrected through modification work conducted at that plant.

The Trenton area also exhibited extensive zones of bacterial degradation which were not always correlated with precipitation events, suggesting the existence of illegal connections and/or presence of still unmeasured sources.

In Picton, the bacteriological degradation zones were smaller than those observed in Belleville and Trenton and were attributable to municipal sewer discharges.

The Deseronto area was found to be the least contaminated by bacteria although higher than background coliform levels recorded at a local beach suggest the existence of a nearby source not investigated in this study.

All the discharges documented on the study area appeared to be intermittent and led only to short term elevations in bacterial levels with the result that seasonal geometric mean levels in 1982 at all public beaches remained below the Provincial Water Quality Objective (PWQO) for fecal coliforms of 100 organisms/100 mL.

FIG. 1 Station Locations, Great Lakes Section, MOE Survey, August 1981.

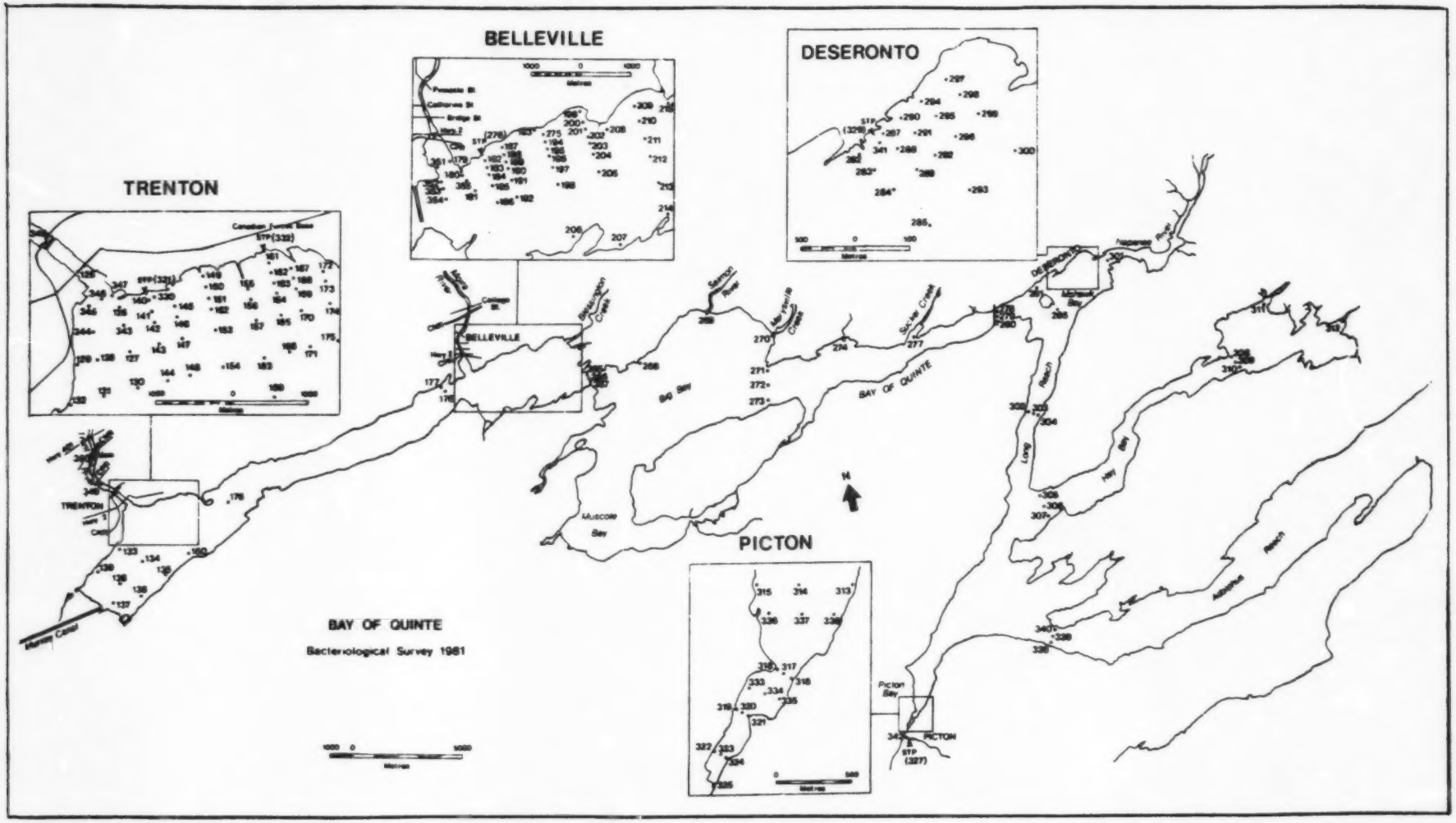


FIG. 2 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 8-10, 1981.

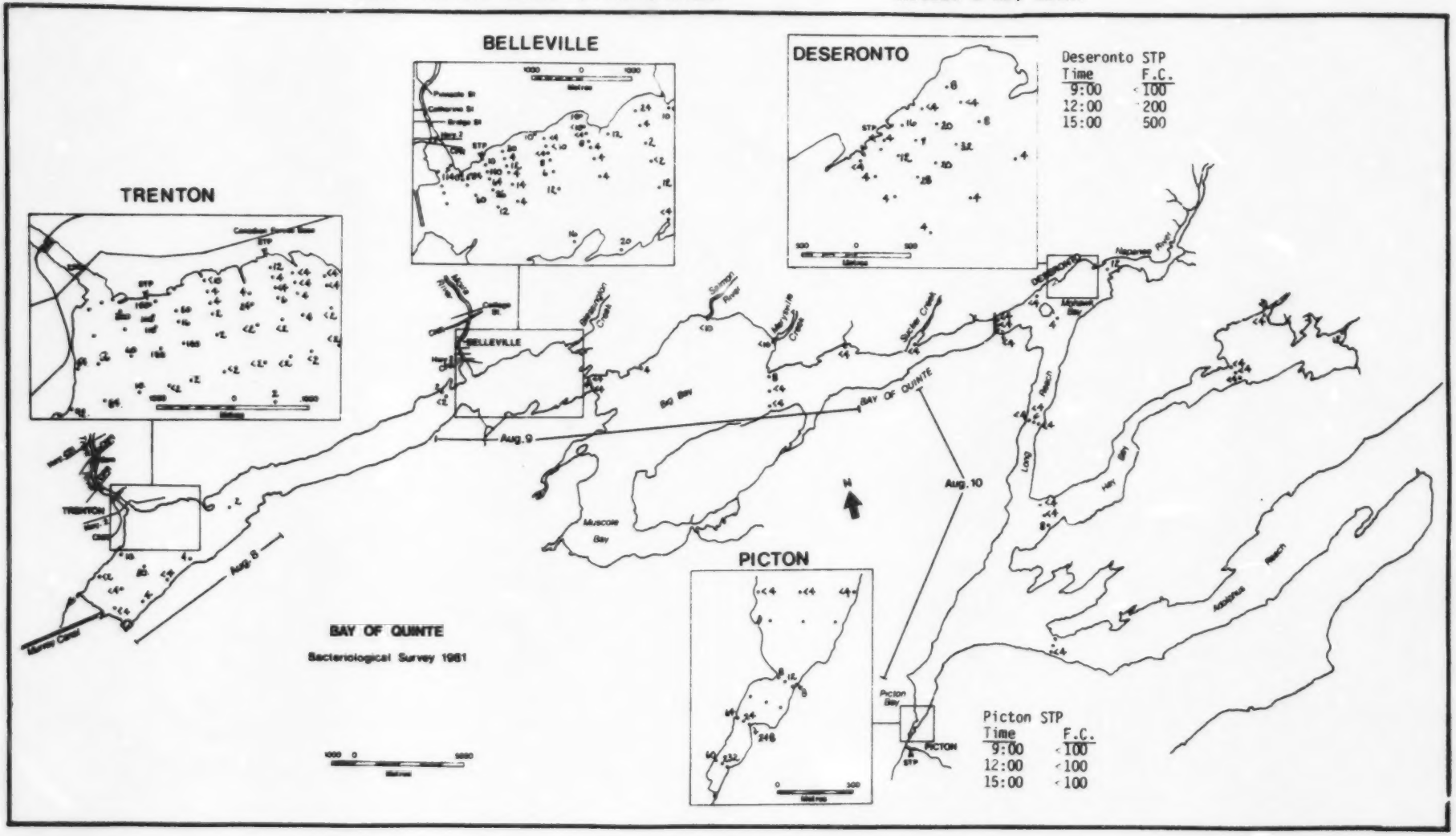


FIG. 3 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 11-13, 1981.

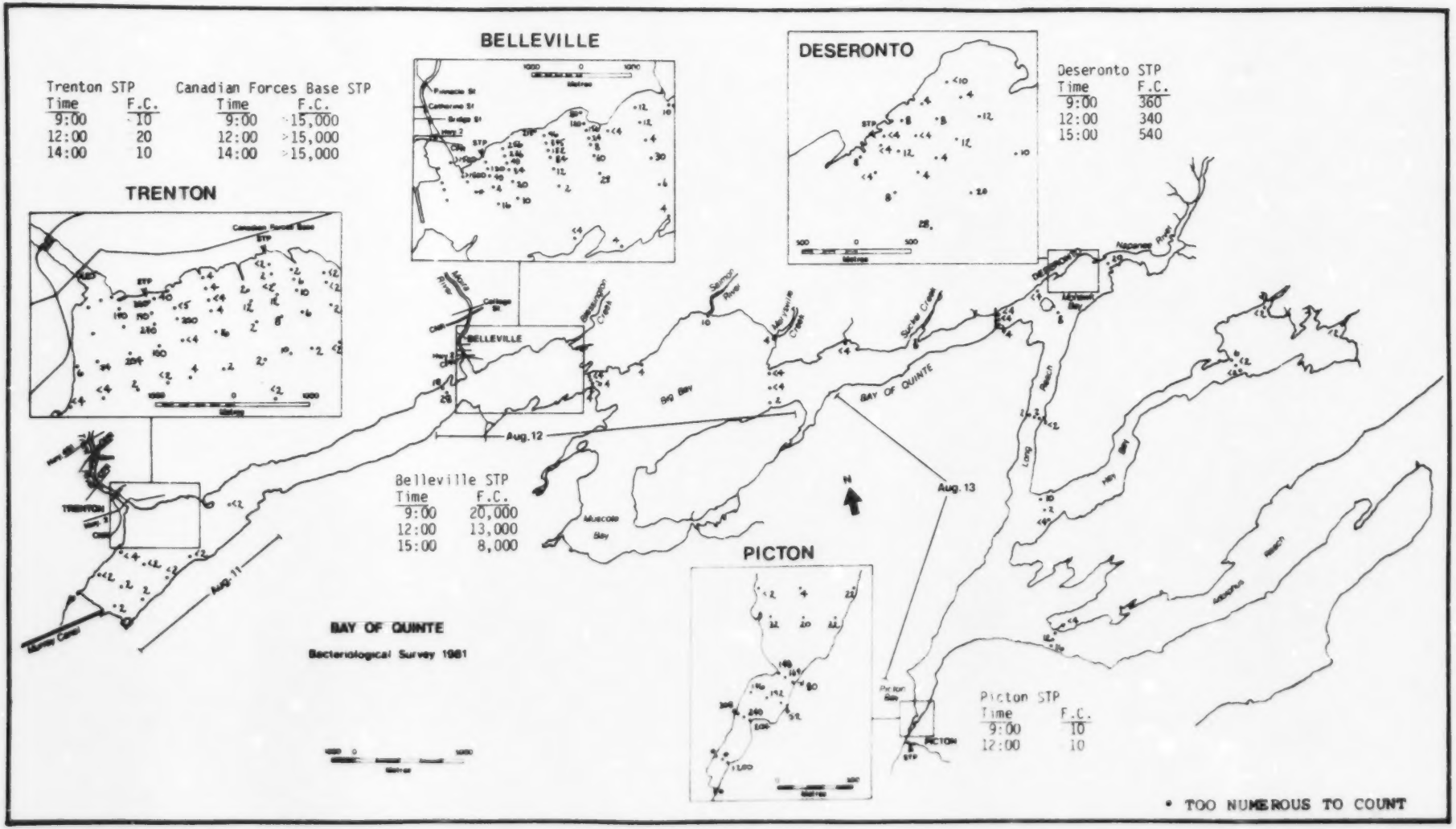


FIG. 4 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 14-16, 1981.

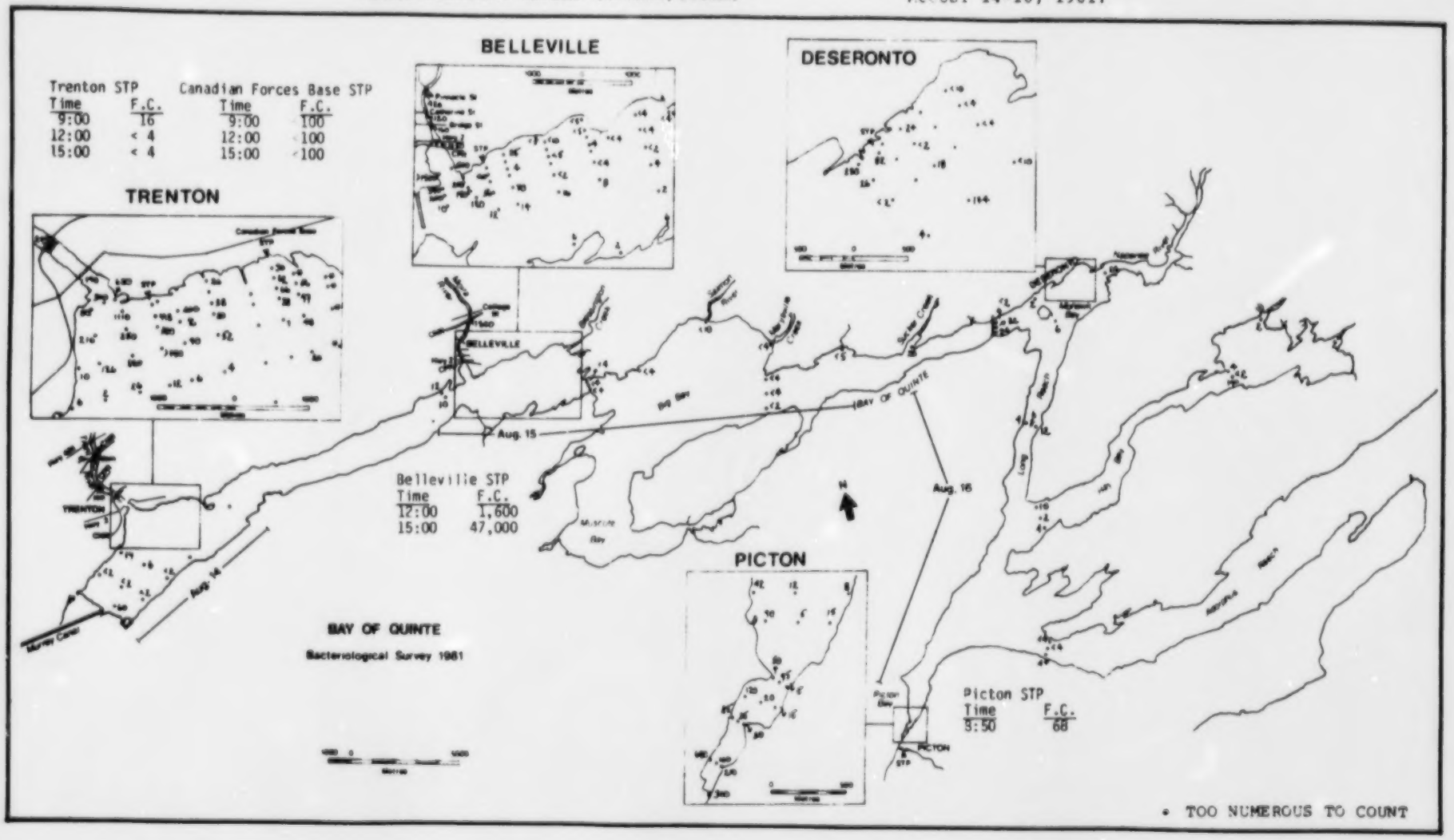


FIG. 5 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 21-23, 1981.

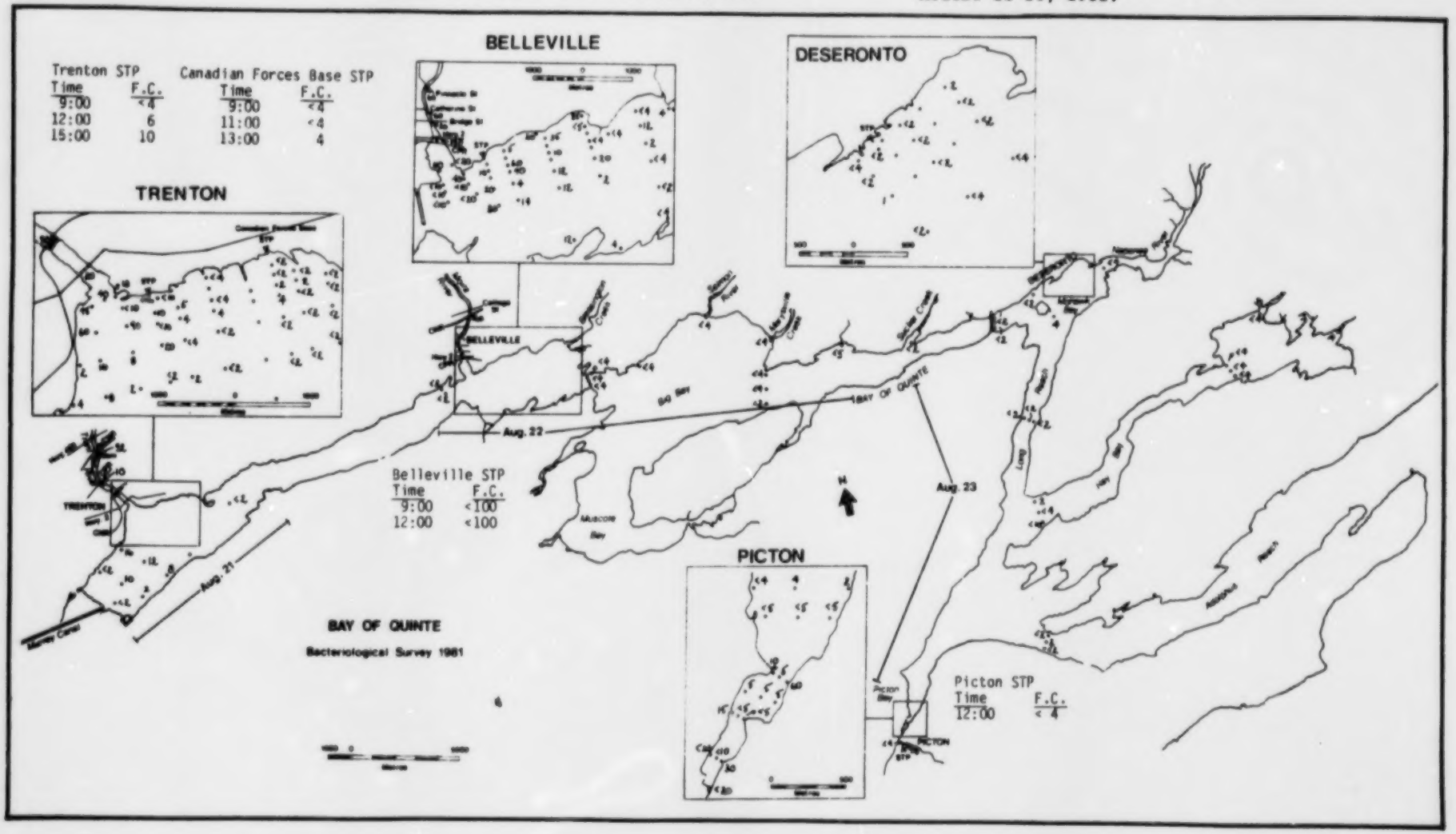


FIG. 6 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 24-26, 1981.

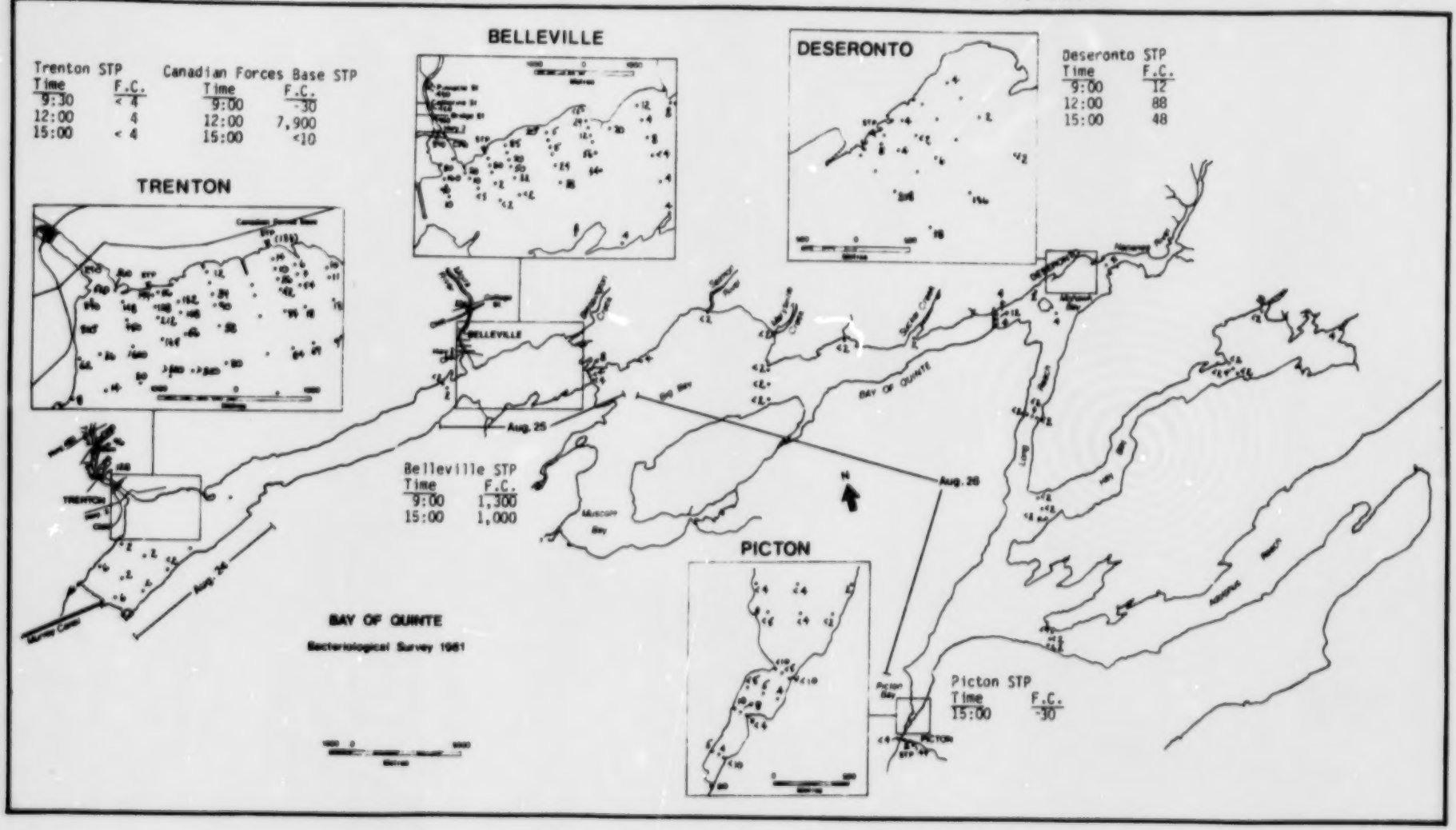


FIG. 7 FECAL COLIFORM LEVELS (COUNTS/100mL) AUGUST 27-29, 1981.

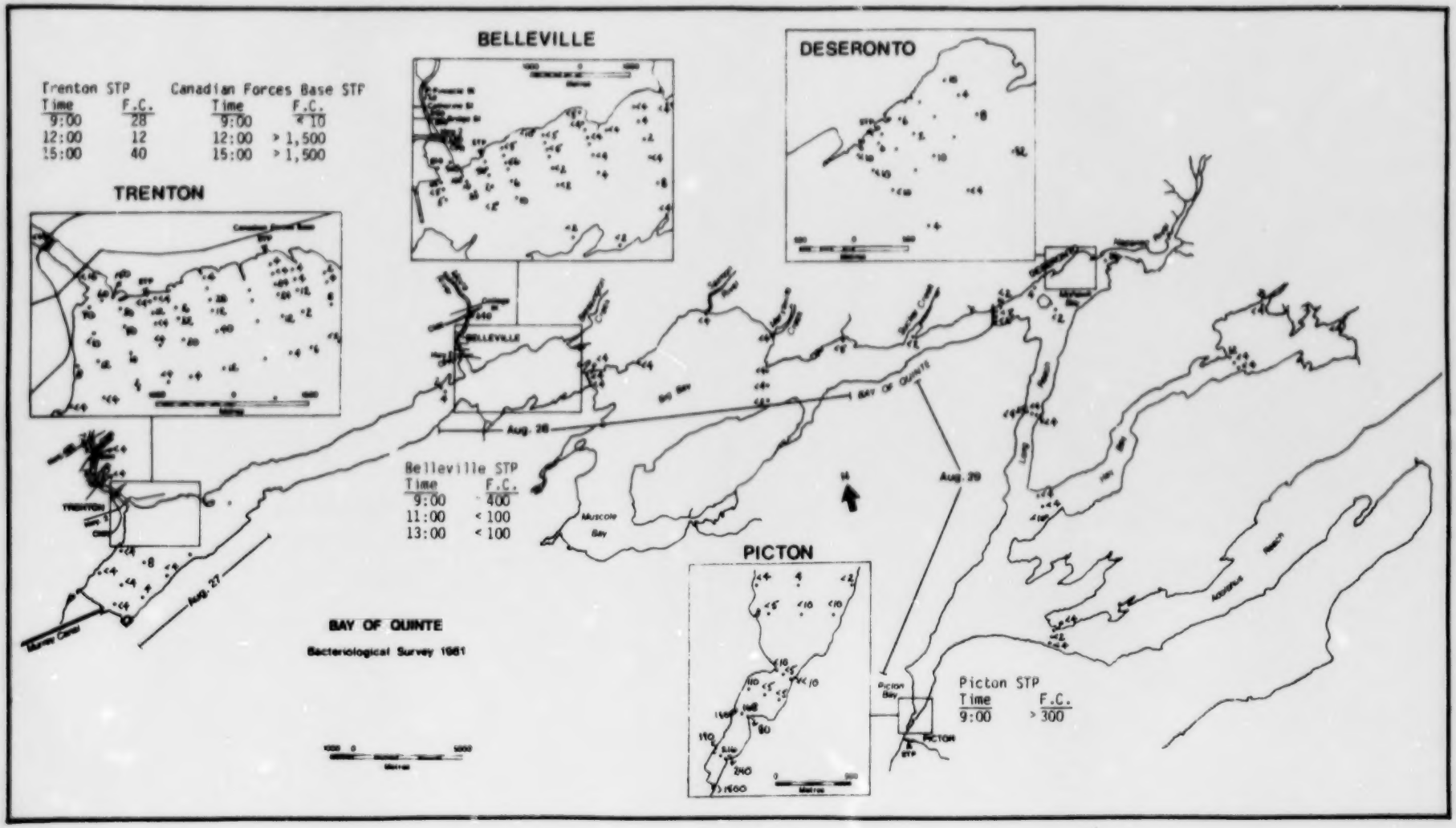
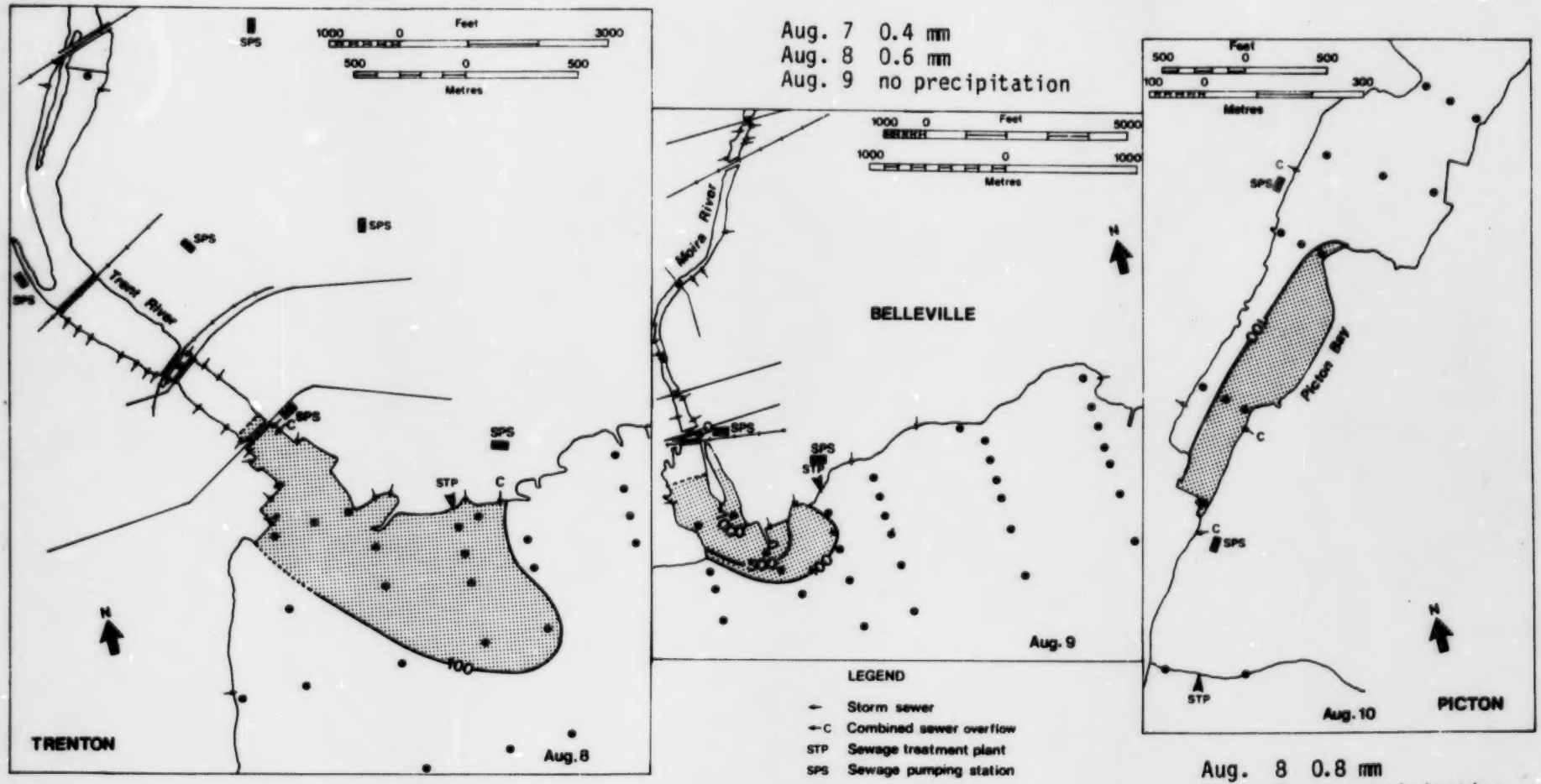


FIG. 8 ZONES ▨ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.

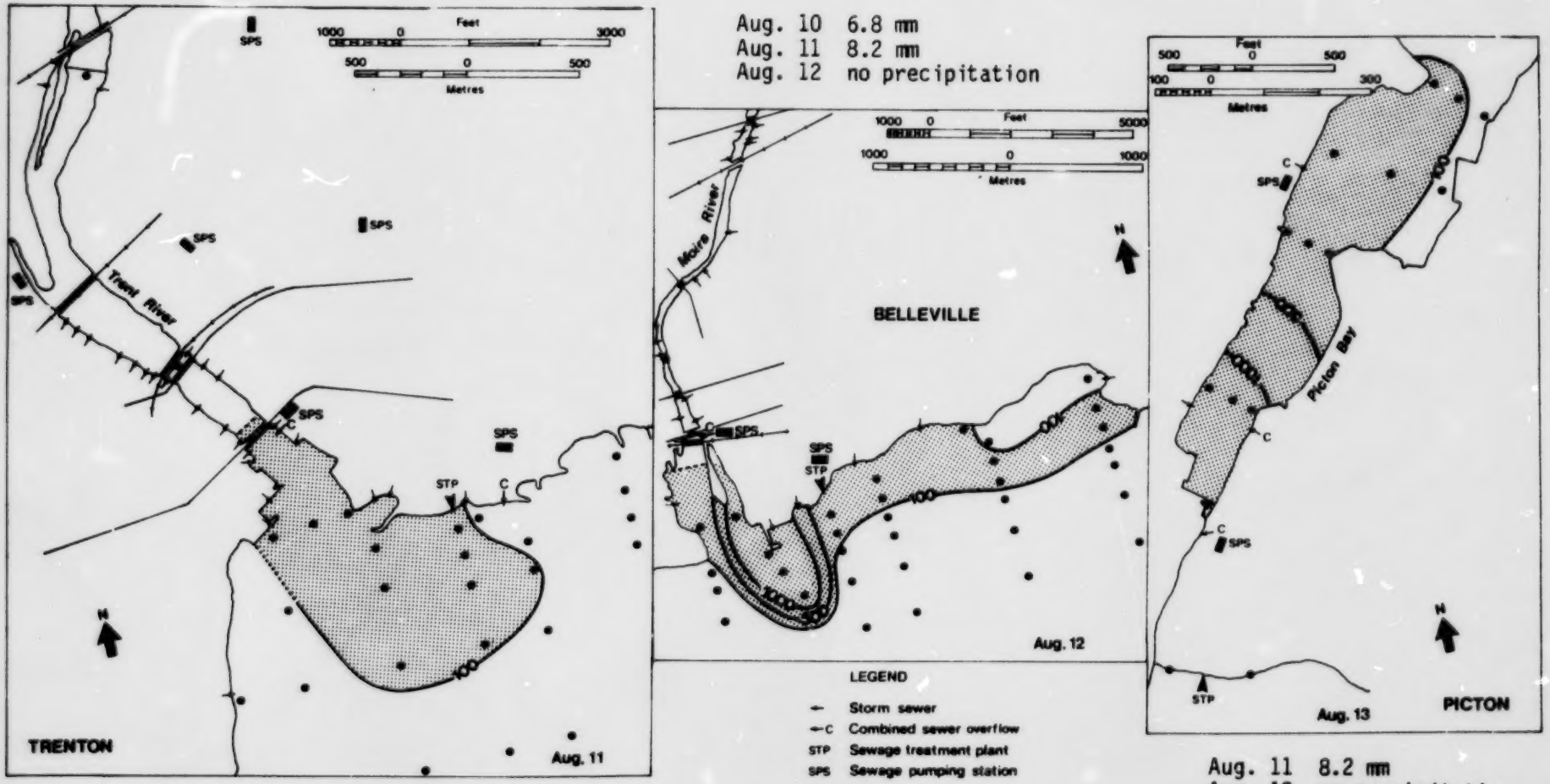


Aug. 6 no precipitation
Aug. 7 0.4 mm
Aug. 8 2.4 mm

Aug. 7 0.4 mm
Aug. 8 0.6 mm
Aug. 9 no precipitation

Aug. 8 0.8 mm
Aug. 9 no precipitation
Aug. 10 4.2 mm

FIG. 9 ZONES ▨ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.

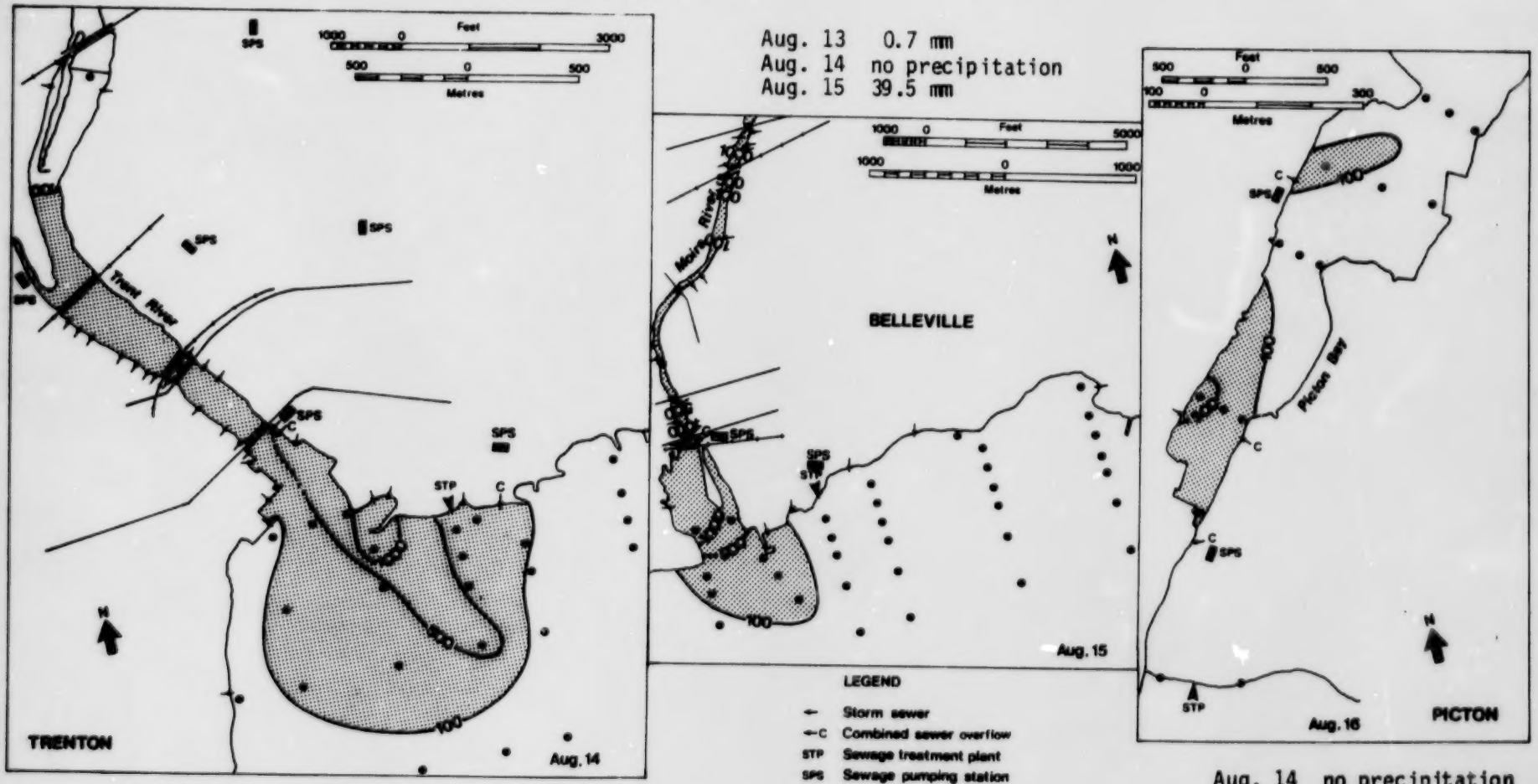


Aug. 9 0.4 mm
Aug. 10 no precipitation
Aug. 11 13.2 mm

Aug. 10 6.8 mm
Aug. 11 8.2 mm
Aug. 12 no precipitation

Aug. 11 8.2 mm
Aug. 12 no precipitation
Aug. 13 no precipitation

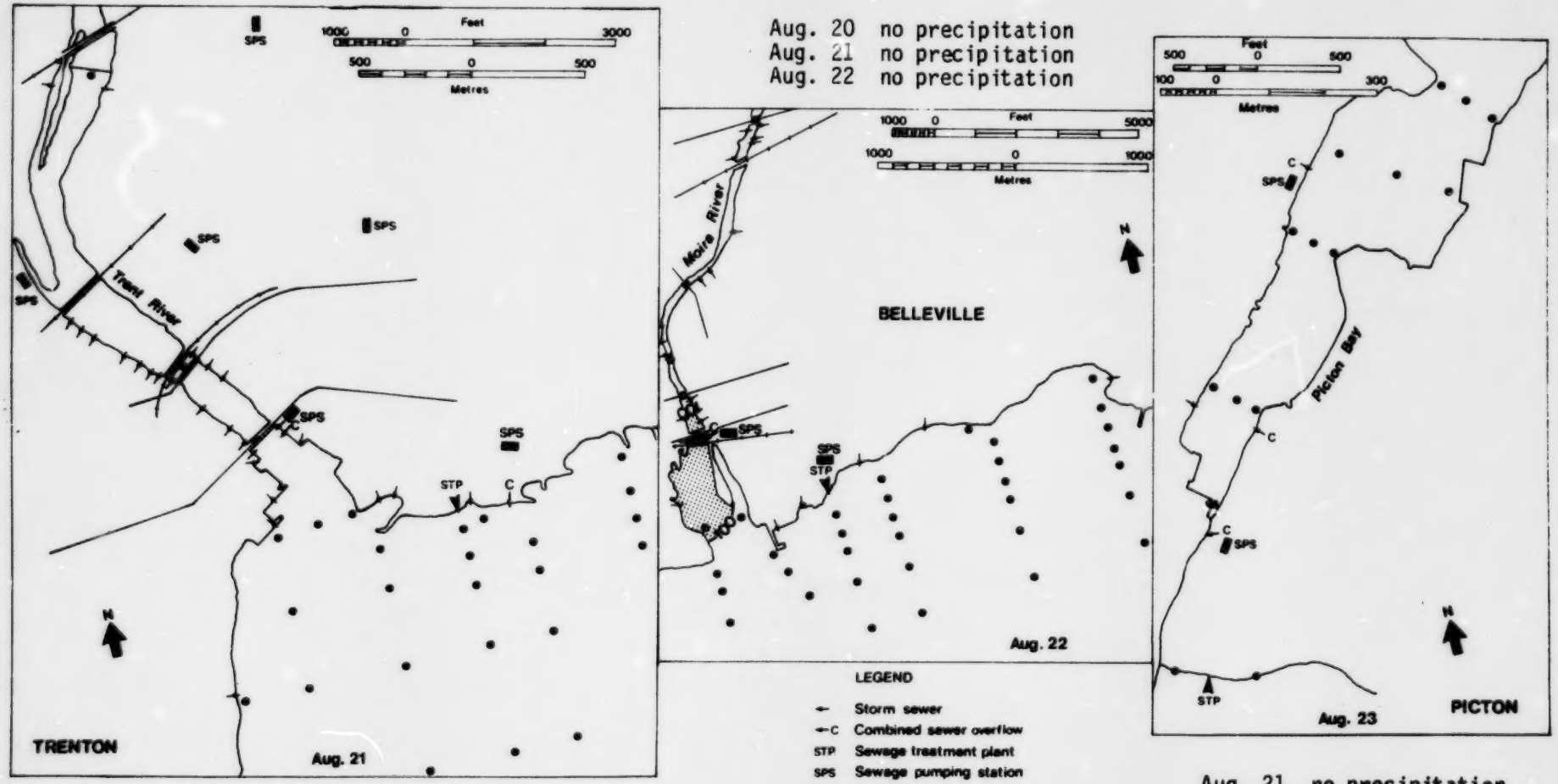
FIG. 10 ZONES ▨ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.



Aug. 12 no precipitation
Aug. 13 no precipitation
Aug. 14 trace precipitation

Aug. 14 no precipitation
Aug. 15 36.6 mm
Aug. 16 no precipitation

FIG. 11 ZONES ▒▒▒ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.



Aug. 19 no precipitation
Aug. 20 no precipitation
Aug. 21 no precipitation

Aug. 20 no precipitation
Aug. 21 no precipitation
Aug. 22 no precipitation

Aug. 21 no precipitation
Aug. 22 no precipitation
Aug. 23 1.4 mm

FIG. 12 ZONES ▨ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.

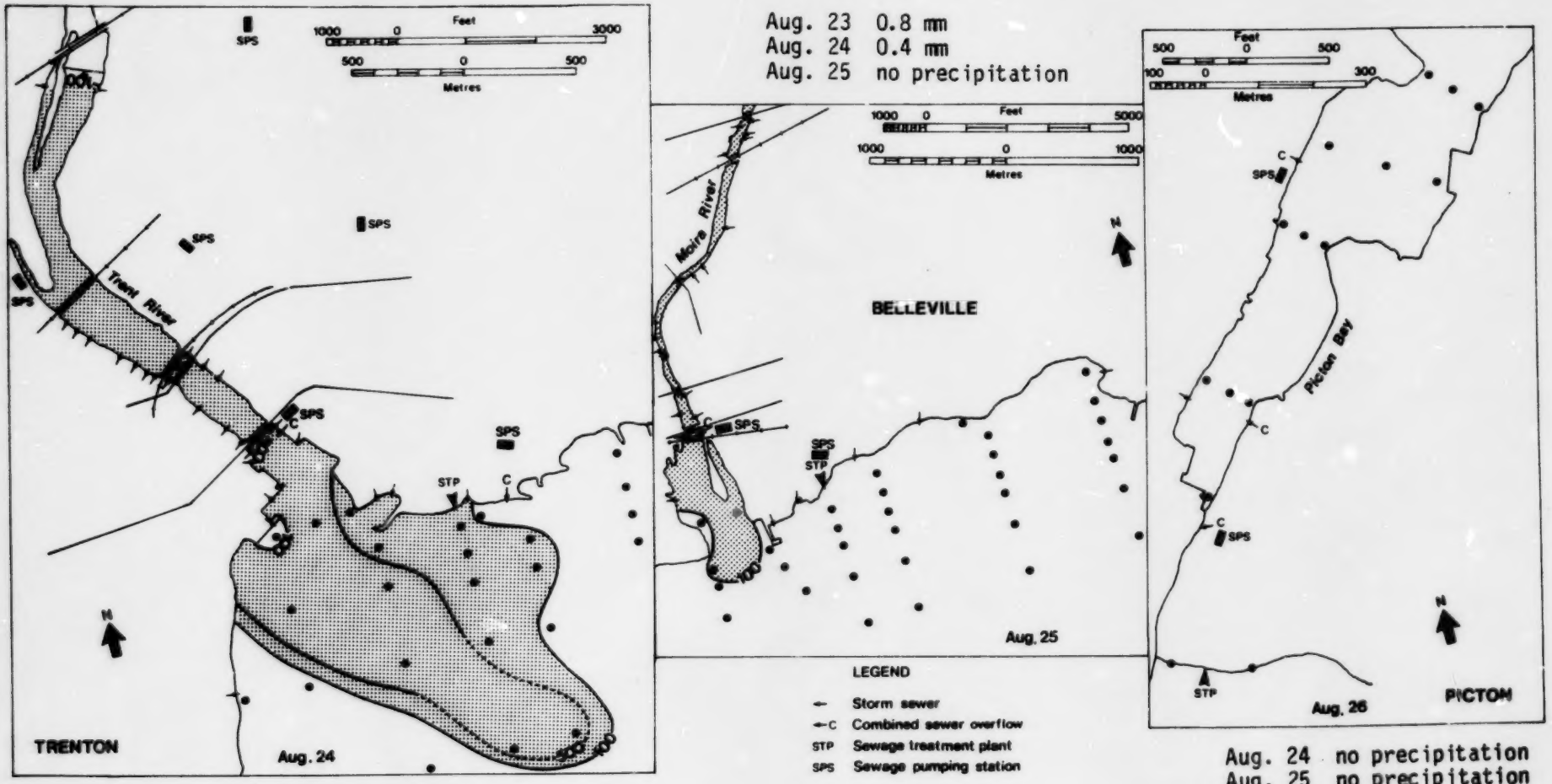


FIG. 13 ZONES ▨ (ABOVE 100 COUNTS/100 ML) OF FECAL COLIFORM LEVELS.

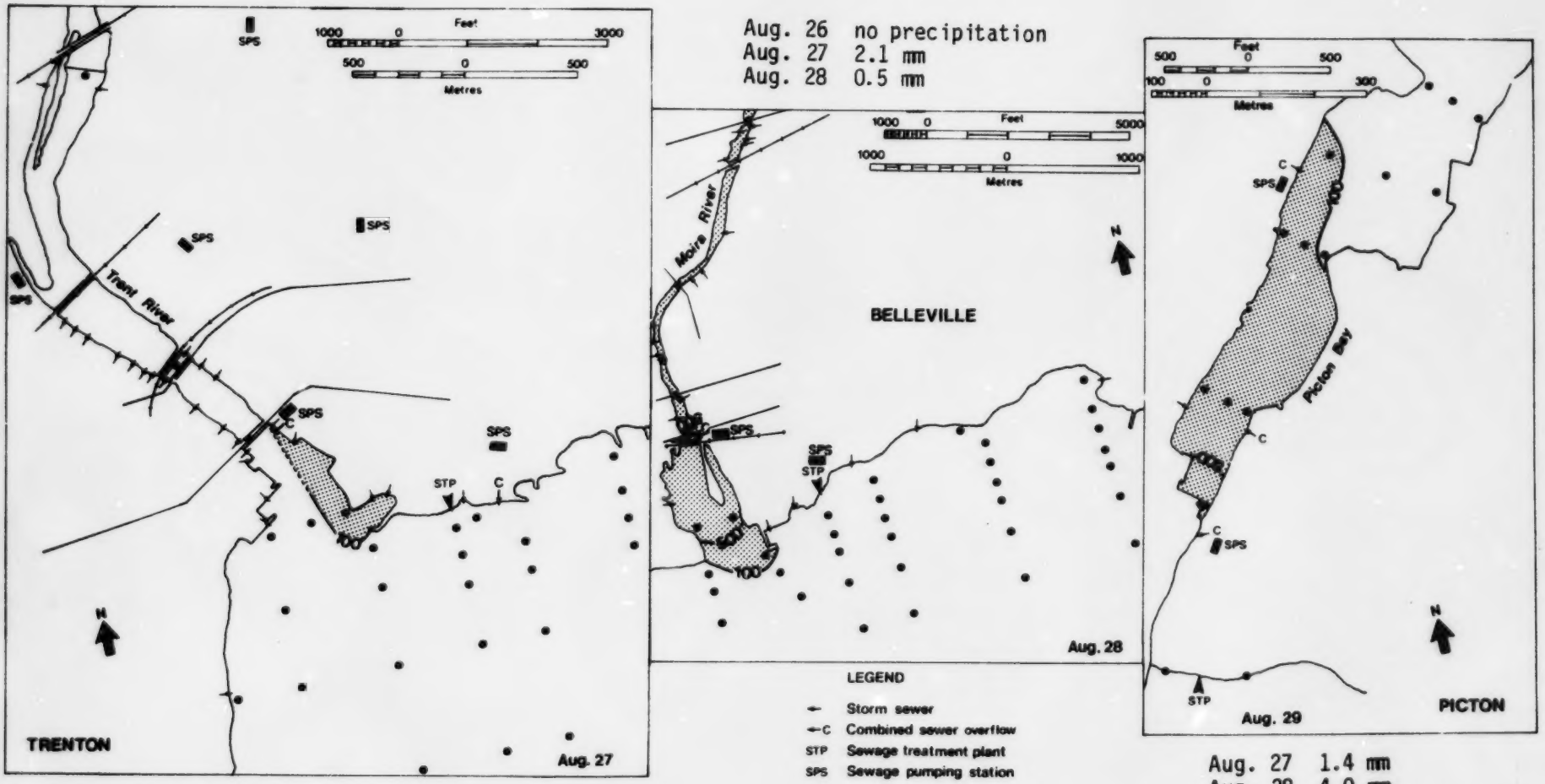
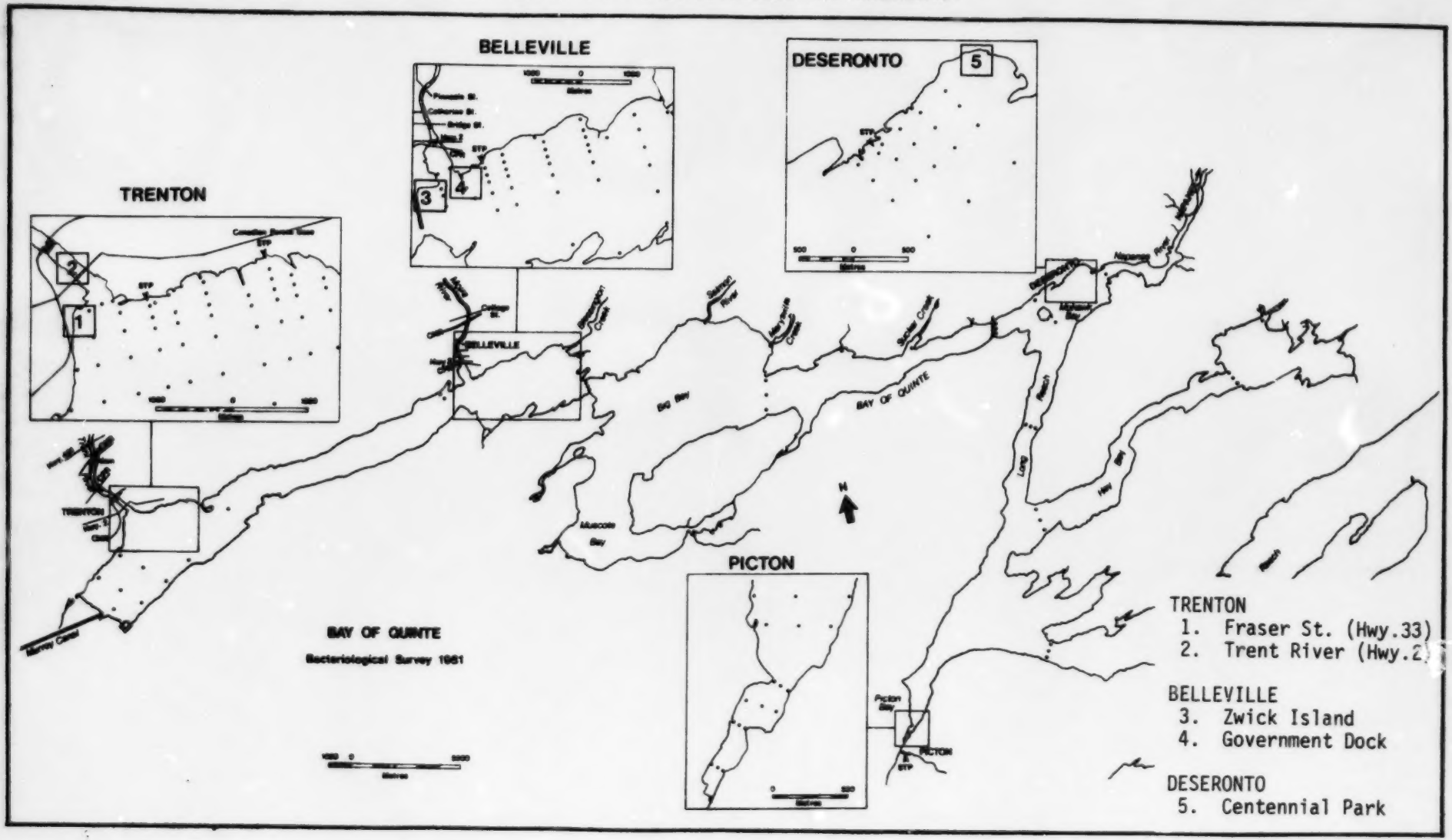


FIG. 14 1982 PUBLIC BEACH SAMPLING LOCATIONS AT TRENTON, BELLEVILLE AND DESERONTO.



POOR

QUALITY

ORIGINAL